of illumination light quantity in said illumination optical system and information of reflection light quantity from said first and second photodetectors, at each operative position in the scan motion, to calculate a ratio between an amount of change in the illumination light quantity information and an amount of change in reflection light quantity information, and wherein said calculating means calculates, in an actual exposure operation, the illumination light quantity solely from the light source on the basis of the calculated ratio.--

REMARKS

Claims 1, 2, 5-8, 10, 11, 15, and 18-32 are now presented for examination. Claim 9 has been cancelled without prejudice or disclaimer of subject matter. Claims 5, 6, 10 and 11 have been amended to define still more clearly what Applicant regards as his invention, in terms which distinguish over the art of record. Claims 29-32 have been added to assure Applicant of the full measure of protection to which he deems himself entitled. Claims 1, 5, 6, 19, 22, 29 and 31 are the only independent claims.

Claims 1, 2, 5-11, 15 and 18 have been rejected under 35 U.S.C. § 102 as anticipated by U.S. Patent 5,591,958 (Nishi et al.). With regard the claims as amended by this amendment, this rejection is respectfully traversed.

Pending independent Claim 1 is directed to scan type exposure apparatus in which a pattern of an original is lithographically transferred to a substrate sequentially while the original and the substrate are scanningly moved relative to exposure light. In the

apparatus, a photodetector disposed in an illumination optical system at a position optically conjugate with the original detects the quantity of light illuminating the original. Correction information with respect to the photodetector output in relation to different positions of the original to be illuminated with exposure light is stored. A correction device receives stored correction information and corrects, in the lithographic transfer, the output of the photodetector by use of the stored correction information.

Pending independent Claim 19 is directed to a scan type exposure apparatus in which a pattern of an original is lithographically transferred to a substrate sequentially while the original and the substrate are scanningly moved relative to exposure light. In the apparatus, a photodetector disposed in an illumination optical system detects the quantity of light illuminating the original. Correction information with respect to the output of the photodetector in relation to different positions of the original to be illuminated with the exposure light is stored. A correction device receives the stored information and corrects, in the lithographic transfer, the output of the photodetector using the stored information.

In Applicant's view, Nishi et al. discloses exposure apparatus that transfers a pattern formed on a mask to a photosensitive substrate. The apparatus is provided with an illumination optical system to illuminate a local area on the mask with a light beam. A projection optical system projects the pattern of the mask to the photosensitive substrate and a relative scanning device relatively scans the mask and the photosensitive substrate in a perpendicular direction to the optical axis of the projection optical system to transfer the pattern of the mask to the photosensitive substrate. An adjusting device adjusts at least one

of the scanning speeds of the mask and substrate, the intensity of the light beam to be incident on the photosensitive substrate and the width of a projection area of the pattern of the mask by the projection optical system in the relative scanning direction in accordance with the change of the sensitivity characteristic of the photosensitive substrate or the change of the intensity distribution of the light beam passing a Fourier transform plane in the illumination optical system with respect to the pattern surface of the mask.

According to the invention of Claims 1 and 19, a photodetector of an illumination optical system detects the quantity of light illumination the original. Correction information from the photodetector output for different positions of the original to be illuminated with exposure light is stored and a correction device operates during lithographic transfer using the stored correction information to correct the output of the photodetector. In Claim 1, the photodetector is positioned optically conjugate with the original.

It is a feature of Claims 1 and 19 that correction information is stored with respect to the output of a photodetector detecting light illuminating an original in relation to different positions of the original to be illuminated with exposure light. As clearly disclosed at lines 55 to 67 of column 11 of Nishi et al.

"Next, after the reticle 12 is placed on the reticle stage system RST, the light amount monitor 58 is shifted in the image field of the projection optical system 8 and the scanning of the reticle 12 is started. The main control system 22A samples the output signal from the light amount monitor 58 during the scanning of the reticle 12, and calculates an

integrated exposure amount after the end of the scanning. This operation is carried out because the energy reaching the wafer 5 is different for each pattern of reticles, so that it is necessary to correct changes of the magnification β and the focus position of the projection optical system 8 by actually monitoring the integrated exposure amount at the time of the scanning exposure." Accordingly, it is not seen that Nishi et al.'s calculating <u>an integrated exposure amount</u> for correction of magnification and focus position during a calibration in any manner teaches or suggests the feature of correction information in relation to different positions of an original to be illuminated with exposure light from a photodetector detecting light illuminating an original as in Claims 1 and 19. Nor does Nishi et al. in any way teach or suggest the further feature of Claims 1 and 19 of correcting the output of the <u>original illumination photodetector</u> during lithographic pattern transfer.

Nishi discloses at lines 23 to 37 of column 11 that "The output value of the refractivity monitor 54 obtained, provided that the reflected light from the wafer 5 will not return to the reflectivity monitor 54, corresponds to the intensity of the reflected light from the reticle 12. Therefore, when this output value is obtained in advance and when the obtained output value is subtracted from the value output from the refractivity monitor 54 in the state that the wafer 5 is positioned under the projection optical system 8, a value corresponding to the intensity of the reflected light from the wafer 5 is calculated. The output signals from the light amount monitor 58, the integrator sensor 46 and the reflectivity monitor 54 are supplied to the exposure control unit 25 via the main control system 22A and utilized to control the amount of exposure." As a result, it is clear that the

measurement of reticle reflected light in Nishi et al. is performed in advance of exposure only to calculate a value for the reflected light from the wafer for calibration of the light amount monitor 58 and there is no arrangement in Nishi et al. to store correction information with respect to an output of the photodetector that detects the quantity of light illuminating the original in relation to different positions of the original to be illuminated by exposure light as in Claims 1 and 19. With respect to measuring the distribution of the pattern of the reticle 12, Nishi et al. clearly discloses at least at lines 1 through 18 of column 12 that the distribution of the pattern of the reticle is determined from the output signal of the light amount monitor 58 solely for the purpose of determining scan speed which is clearly directed away from the invention of Claims 1 and 19.

It is a further feature of Claim 1 that the photodetector which detects a quantity of light illuminating the original is at a position optically conjugate with the original. Fig. 1 of Nishi et al. shows the light paths between a reticle 12 and the integrator sensor 46 and the light paths between the reticle 12 and the reflectivity monitor 54. It is clear from Fig. 1 that only light from an extended area of the reticle reaches either the reflectivity monitor 54 or the integrator sensor 46 and there is no focused position on the reticle that has a light path to a corresponding focused position on either reflectivity monitor 54 or integrator sensor 46. The optically conjugate relationships disclosed in Nishi et al. are only between elements such as that shown in Fig. 5 wherein the pattern of the reticle 101 is projected to a wafer area 147 conjugate to the illumination area 146 with respect to the projection optical system 109 or that of the movable light shielding plates

138 and 139, the blades 138y and 139y for setting an illumination field on the reticle 101 in the scanning direction (Y direction) are disposed in a plane conjugate to the pattern surface of the reticle 101. In at least the foregoing respects, it is believed that pending Claims 1 and 19 are completely distinguished from Nishi et al. and are allowable.

Independent Claim 5 as amended by this amendment is directed to scan exposure apparatus in which a pattern of an original is transferred to a substrate sequentially while the original and the substrate are scanningly moved relative to exposure light. In the apparatus, a first photodetector disposed at a position optically conjugate with the original detects information regarding the original and produces an output. A second photodetector detects reflection light from the original and produces an output. Correction information with respect to the output of the first photodetector in relation to different positions of the original is stored on the basis of the outputs of the first and second photodetectors. A correction device receives the stored correction information and corrects, in the lithographic transfer, the output of the first photodetector using the correction information.

It is a feature of Claim 5 as amended that correction information is formed and stored with respect to the output of a first photodetector optically conjugate with an original that detects information regarding the original in relation to different positions of the original on the basis of outputs of the first photodetector and a second photodetector that detects and outputs reflection light from the original. It is a further feature that a

correction device corrects the output of the first photodetector in a lithographic pattern transfer using the correction information.

As discussed with respect to Claims 1 and 19, there is no teaching or suggestion in Nishi et al. of a photodetector at a position optically conjugate with an original that detects the light quantity illuminating an original. As clearly shown in Fig. 1, reflection monitor 54 and integrator sensor 46 of Nishi et al. could only receive light from an extended area of the monitored reticle rather than from different focused positions as required by Claim 5. As a result, there is no suggestion in Nishi et al. of correction information with respect to the output of a photodetector in relation to different positions of an original. Nishi et al. only provides integrated information using integrator sensor 46 from the scanning operation prior to exposure. Further, as discussed with respect to Claims 1 and 19, Nishi et al. only teaches that the measurement of reflected light from the reticle 12 by reflection monitor 54 in advance of exposure without return from the wafer is performed to calculate the reflected light from the wafer 5 and that the wafer light amount monitor 58 is the device that detects the pattern distribution of the reticle for scanning speed determination. Accordingly, Nishi et al. is devoid of any teaching or suggestion of correcting the output of a photodetector with stored correction information in relation to different positions of the original as in Claim 5. It is therefore believed that Claim 5 as amended is completely distinguished from Nishi et al. and is allowable.

Independent Claim 6 as amended by this amendment is directed to scan type exposure apparatus in which a pattern of an original is lithographically transferred to a

substrate sequentially while the original and the substrate are scanningly moved relative to exposure light. In the apparatus, an illumination optical system illuminates an original with exposure light output from a light source. A projection optical system projects a pattern of the original illuminated by the illumination optical system onto a substrate. A photodetector disposed in the illumination optical system at a position optically conjugate with the original detects the quantity of light illuminating the original. A control unit controls the exposure light output from the light source on the basis of the output of the photodetector and a correcting unit reduces the influence of reflection light from the original on the basis of the output of the photodetector as the original is illuminated by illumination optical system.

Pending independent Claim 22 is directed to an exposure apparatus in which an illumination optical system illuminates an original with exposure light output from a light source and a projection optical system projects a pattern of the original illuminated by the illumination optical system onto a substrate. A photodetector disposed in the illumination optical system detects the quantity of light illuminating the original and a correction unit reduces the influence of reflection light from the original on the basis of the photodetector output as the original is illuminated by the illuminating optical system.

According to the invention defined in Claims 6 and 22, exposure light output from a light source is controlled on the basis of the output of a photodetector disposed in an illumination optical system that detects the quantity of light illuminating an original. Correcting means reduces the influence of reflection light from the original based

on the output of the photodetector as the original is illuminated by the illumination optical system.

As discussed with respect to Claims 1 and 19, neither the integrator sensor 46 nor the reflectivity monitor 54 operates as a photodetector disposed in an illumination optical system for detecting a quantity of light illuminating the original. As a result, the outputs of these photodetectors which measure wafer reflected light and integrated exposure amount do not operate to reduce the influence of reflection light from the original as in Claims 6 and 22.

Further, as discussed with respect to Claims 1 and 19, Nishi et al. determines the distribution of the pattern of the reticle from the output signal of the wafer light amount monitor 58 rather than from light reflected from the reticle as in Claims 6 and 22. Accordingly, it is not seen that Nishi et al.'s calculating an integrated exposure amount for correction of magnification and focus position by an integrator sensor 46 and the measuring of the intensity of the reflected light from the wafer 5 by the reflectivity monitor 54 during exposure could possible teach or suggest the features of Claims 6 and 22. It is therefore believed that Claim 6 as amended by this amendment and pending Claim 22 are completely distinguished from Nishi et al. and are allowable.

Newly added Claim 29 is directed to scan exposure apparatus in which an illumination optical system illuminates an original in a predetermined shape with light from a light source. A projection optical system projects a pattern of the original illuminated by the illumination optical system onto a substrate. A photodetector disposed inside the

illumination optical system detects the quantity of illumination light in the illumination optical system and provides illumination light quantity output information relative to each operative position in scan motion. A first control unit controls the output of the light source according to each output of the photodetector. A storing unit reduces or removes, relative to different positions on the original illuminated in the predetermined shape, a component of reflection light from the original included in the photodetector output. A calculating unit receives correction information held by the storing unit and receives illumination light quantity information from the photodetector in each operative position in the scan motion to calculate, according to the correction information, information on the illumination light quantity solely from the light source without being influenced by the reflection light component. A second control unit receives the illumination light quantity information solely from the light source calculated by the calculating unit to control the output of exposure light from the light source so that the illumination light quantity solely from the light source is kept at a predetermined value at each operative position in the scan motion.

It is a feature of Claim 29 that a component of reflection light in relation to different positions of an original illuminated in a predetermined shape from a photodetector that detects quantify of illumination light in an illumination optical system is reduced or removed and that correction information for calculating the illumination light solely from a light source is held. It is another feature of Claim 29 that information on the illumination light quantity solely from the light source without being influenced by the reflection light

component is calculated from the held correction information and received illumination light quantity information from the photodetector in each operative position in the scan motion and that the output of exposure light from the light source is controlled so that at each operative position in the scan motion the illumination light quantity solely from the light source is kept at a predetermined value.

Nishi et al. may teach a scan exposure apparatus using a photodetector, a storing unit and a correction device. In Nishi et al., as discussed with respect to Claims 6 and 22, an integrator sensor 46 operates to calculate an integrated exposure amount to correct magnification and focus position and to measure wafer surface illuminance and a reflectivity monitor 54 operates to measure intensity of reflected light from a wafer 5 when the image of the reticle pattern on the wafer 5 while the reticle 12 and the wafer 5 are shifted synchronously. These photodetecting devices only detect integrated exposure light and light reflected from a wafer but do not in any manner detect a quantity of illumination light in an illumination optical system and provides an output of illumination light quantity information in relation to each operative position in scan motion as in Claim 29.

With regard to the feature of Claim 29 of reducing or removing, in relation to different positions on the original illuminated in the predetermined shape, a component of reflection light from the original included in the photodetector output, and for holding correction information for calculation of an illumination light quantity solely from the light source, Nishi et al. only teaches measurement of reticle reflected light performed in advance of exposure only to calculate a value for the reflected light from the wafer for

calibration of the light amount monitor 58 but is devoid of any suggestion of reducing or removing a component of reflection light of an original from detected illumination light as in Claim 29.

Nishi et al. may teach calculating a value for reflected light from a wafer using reticle reflected light measured without a wafer inserted for calibration but fails in any manner to teach or suggest the features of Claim 29 of calculating, according stored correction information, information on illumination light quantity solely from the light source, without being influenced by the reflection light component combined with the feature of controlling, based on the calculated information of illumination light quantity solely from the light source, output of exposure light from the light source so that, at each operative position in a scan motion, the illumination light quantity solely from the light source is kept at a predetermined value. In at least the foregoing respects, it is believed that newly added Claim 29 is completely distinguished from Nishi et al. and is allowable.

Newly added Claim 31 is directed to scan type exposure apparatus in which an illumination optical system illuminates an original in a predetermined shape with light from a light source. A projection optical system projects a pattern of the original illuminated by the illumination optical system onto a substrate. A first photodetector disposed inside the illumination optical system detects the quantity of illumination light in the illumination optical system and provides an output of illumination light quantity information relative to each operative position in scan motion. A second photodetector detects the quantity of light from the original and provides an output of reflection light

quantity from the original information at each operative position in the scan motion. A calculating unit calculates the illumination light quantity solely from the light source on the basis of the illumination light quantity information from the first photodetector and the reflection light quantity information from the second photodetector. A correction unit receives an output from the calculating unit and receives, at each operative position of the scan motion, illumination light quantity information from the first photodetector and the reflection light quantity information from the second photodetector to calculate information of the illumination light quantity solely from the light source which excluding influence of the reflection light component on the basis of the output. A control unit receives the information of the illumination light quantity solely from the light source with the influence of the reflection light component being excluded on the basis of the correction unit output and controls output of exposure light from the light source so that, at every operative position in the scan motion, the illumination light quantity solely from the light source is kept at a predetermined value.

Nishi et al. may disclose an integrator sensor 46, a reflectivity monitor 54 and a wafer light amount monitor 58 in a scan exposure apparatus. None of these photodetectors of Nishi et al., however, operate as a first photodetector inside an illumination optical system that detects the quantity of light of the illumination relative to each operative position in a scan motion or as a second photodetector that detects a quantity of reflection light from an original and outputs reflection light quantity information from the original at each operative position in the scan motion. Nor is there any arrangement in

Nishi et al. in which a correction unit calculates the illumination light quantity solely from the light source based on the first and second photodetector outputs and wherein the illumination light quantity solely from the light source with the influence of reflection light excluded is calculated on the basis of the outputs of the first and second photodetectors. Rather, the integrator sensor 46 of Nishi et al. operates to calculate an integrated exposure amount to correct magnification and focus position and to measure the wafer surface illuminance. The reflectivity monitor 54 of Nishi et al. operates to measure intensity of reflected light from a wafer 5 when the image of the reticle pattern on the wafer 5 while the reticle 12 and the wafer 5 are shifted synchronously, and the wafer light amount monitor 58 of Nishi et al. monitors the exposure light illuminating the wafer.

Further, Nishi et al. is devoid of any disclosure of calculating the illumination light quantity solely from the light source with the influence of reflection light excluded on the basis of the output of the first photodetector of the quantity of light of the illumination relative to each operative position in a scan motion and the output of the second photodetector of reflection light quantity information from the original at each operative position in the scan motion and thereafter controlling the output of exposure light from the light source on the basis of the correction unit output so that the illumination light quantity solely form the light source. As discussed with respect to Claims 1 and 19, the only measurement of reticle reflected light in Nishi et al. is performed in advance of exposure by removing the wafer and only to calculate a value for the reflected light from the wafer for calibration of the light amount monitor 58. Accordingly, it is not seen that

Nishi et al. in any manner suggests these features of Claim 31. It is therefore believed that newly added Claim 31 is completely distinguished from Nishi et al. and is allowable.

A review of the other art of record has failed to reveal anything which, in Applicant's opinion, would remedy the deficiencies of the art discussed above, as references against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicant respectfully requests favorable consideration and reconsideration and early passage to issue of the present application.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

5. (Twice Amended) [An] A scan type exposure apparatus [for lithographically transferring a pattern of an original onto a substrate] wherein a pattern of an original is lithographically transferred to a substrate sequentially while the original and the substrate are scanningly moved relative to exposure light, said apparatus comprising:

a first photodetector, disposed at a position optically conjugate with the original, for detecting information regarding the original and for producing an output;

a second photodetector for detecting reflection light from the original and for producing an output;

storing means for storing correction information with respect to the output of said first photodetector in relation to different positions of the original, on the basis of the outputs of said first and second photodetectors; and

a correction device receiving the correction information stored in said storing means and for correcting, in the lithographic pattern transfer, the output of said first photodetector by use of the correction information.

6. (Three Times Amended) [An] A scan type exposure apparatus wherein a pattern of an original is lithographically transferred to a substrate sequentially while the original and the substrate are scanningly moved relative to exposure light, comprising:

an illumination optical system for illuminating an original with exposure light output from a light source;

a projection optical system for projecting a pattern of the original, illuminated by the illumination optical system, onto a substrate;

a photodetector disposed in said illumination optical system and at a position optically conjugate with the original, for detecting a quantity of light illuminating the original;

control means for controlling the exposure light output from the light source on the basis of the output of the photodetector; and

correcting means for reducing an influence of reflection light from the original, on the basis of the output of the photodetector as the original is illuminated by the illumination optical system.

Claim 9 has been cancelled.

10. (Twice Amended) An apparatus according to Claim 7, [wherein said exposure apparatus is a scan type exposure apparatus in which exposure is performed while the original and the substrate are scanningly moved relative to the exposure light from said illumination optical system and relative to said projection optical system,] wherein said light source comprises a discharge lamp, said correcting means operates so that (i) outputs

of said photodetector in relation to each movement position are obtained beforehand while an applied electric power to said discharge lamp is kept constant and while the scan motion is performed at a speed lower than an ordinary scan speed, (ii) during the procedure in (i), the output of said photodetector in a state in which there is no light coming from the original and directed to said photodetector is obtained, (iii) in actual exposure of the substrate, at a start of the scan motion, an output of said photodetector in a state in which there is no reflection light coming from the original and directed back to said photodetector is obtained, and (iv) at each of the movement positions in the scan motion, any influence of reflection light is removed or reduced on the basis of the output in (iv) and the outputs having been obtained beforehand, and said control means controls, at each of the movement positions in the scan motion, the exposure light output from said light source on the basis of an output of said photodetector with the influence of reflection light being removed or reduced.

11. (Twice Amended) An apparatus according to Claim 8, [wherein said exposure apparatus is a scan type exposure apparatus in which exposure is performed while the original and the substrate are scanningly moved relative to the exposure light from said illumination optical system and relative to said projection optical system,] wherein said light source comprises a discharge lamp, said correcting means operates so that (i) outputs of said photodetector and outputs of said reflection light detecting means in relation to each

movement position are obtained beforehand while an applied electric power to said discharge lamp is kept constant and while the scan motion is performed at a speed lower than an ordinary scan speed, and (ii) in actual exposure of the substrate, at each of the movement positions in the scan motion, any influence of reflection light is removed or reduced on the basis of the output of said photodetector and a result of detection by said reflection light detecting means, and said control means controls, at each of the movement positions in the scan motion, the output of said light source on the basis of an output of said photodetector with the influence of reflection light being removed or reduced.

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